Capitation and Risk Adjustment in Health Care Financing: An International Progress Report

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AN ENORMOUS DIVERSITY EXISTS IN THE METHODS of financing health care in the developed world (Hoffmeyer and McCarthy 1994). There is, however, one feature common to almost all systems of health care. Society—often in the form of the national government—in effect seeks to devolve responsibility for arranging health care to a variety of purchasers. These purchasers might be commercial insurance pools (as in the U.S. Medicare system), local governments (in Scandinavia), local administrative boards (as in the United Kingdom, New Zealand, and many Australian states and Canadian provinces), or sickness funds (as in the Netherlands, Belgium, Israel, and Germany). We call these organizations health care plans. Whatever their precise constitution, these plans are charged with purchasing specified types of health care for a designated population (whether defined by geography, employment type, or voluntary enrollment) over a given time period. To an increasing extent, such plans have been an important focus for securing important health care objectives, such as controlling expenditures or enhancing equity. To this end, a central feature of all the arrangements mentioned above is the requirement to set a prospective budget that reflects some concept of fairness. The intention is that the plan

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then deliver the required health care to the population at risk within the specified budget.

A number of methods have been used to construct prospective budgets for health plans—for example, bilateral negotiations between funder and plan, or extrapolation of historical expenditure levels. However, such methods are, in general, heavily criticized because they appear arbitrary and may perpetuate existing inefficiencies and inequities. Increasing use has therefore been made of more scientific approaches to setting budgets, most notably in the form of capitation payments (Newhouse 1998).

A capitation payment is defined as the contribution to a plan's budget associated with a plan member for the service in question for a given period of time. In the context of competitive insurance markets, capitation payments have also been referred to as premium subsidies, the *ex ante* subsidy paid by a sponsor or regulator to a health plan (e.g., from the U.S. Health Care Financing Administration to HMOs on behalf of Medicare beneficiaries) (Van de Ven and Ellis 2000). Clearly the health care expenditure needs of citizens vary considerably, depending on personal characteristics such as age, morbidity, and social circumstances. More refined forms of capitation systems therefore employ methods of risk adjustment, which seek to adjust per capita payments to reflect the relative expected health service expenditure for plan members on the basis of personal characteristics.

Although part of an individual's health care expenditure needs are, in principle, predictable and therefore capable of being modeled by a capitation payment, a large element is entirely random. In being required to provide care within a fixed budget, the plan therefore (to a greater or lesser extent) assumes some risk in the form of unpredictable expenditure variability. The exact nature and magnitude of that risk will be somewhat influenced by the accuracy of the capitation payment, as well as by the size of the risk pool and the risk management procedures put in place, such as cost sharing and retrospective adjustment of budgets.

In spite of the widespread acceptance of the use of capitation and risk adjustment, particularly within mature health care systems, the methodology and implementation of these important tools varies markedly across both countries and health care systems (Hutchison, Hurley, Reid, et al. 1999; McCarthy, Davies, Gaisford, et al. 1995; Oliver 1999). The purpose of this paper is to review and examine the methods of capitation and risk adjustment used to distribute health care funds to health

care plans in developed nations. It excludes consideration of capitation payments to providers.

The progress of policy and research relating to capitation in the United States has been well documented in the literature—see, for example, the Summer 1998 issue of *Inquiry*. The survey is therefore restricted to nations outside the United States. Van de Ven and Ellis (2000) document in some detail the experiences in competitive health plan markets. This paper surveys experiences across a wider range of health care systems, which we classify into four broad types: competitive insurance markets, captive employment-based insurance, devolved public sector, and centralized public sector. First, we introduce the concept of a capitation payment and how it is used. Next, we discuss the implicit and explicit objectives attached to capitation schemes. We then provide a summary of the existing methods for setting capitation payments. In the following section, we describe the needs factors currently used to determine capitation payments, and in the concluding section, we speculate on possible future developments.

The Rationale for Capitation in Health Care Finance

A capitation system puts a price on the "head" of every plan member, and at its simplest (as in Spain) might assign an equal amount of funding for every citizen, regardless of circumstances (Consejo de Politica Fiscal y Financiera 1998). Successive degrees of refinement using risk adjustment can then be envisaged. For example, in many of the risk-adjustment schemes used in systems of social insurance (e.g., Israel, Germany, and Switzerland), the capitation payment is based on rudimentary demographic data, thereby introducing a number of different categories of individual based on age and sex. Clearly, age and sex are important determinants of expenditure variations, but many other potential risk adjusters exist. In incorporating further factors into the risk-adjustment mechanism, most capitation schemes have been constrained by data availability.

The plan may not necessarily be required to spend at the level of funding assumed by the central authority. For example, in Scandinavian health care systems, local governments can, to some extent, vary their funding levels from those assumed by the central government by changing local

taxes or copayments from the levels assumed by the national government (Rattso 1998); in Switzerland, sickness funds might finance variations from assumed expenditure levels by varying the insurance premiums they charge (McCarthy, et al. 1995).

Although a given capitation payment may be notionally assigned to an individual, the large random element associated with an individual's expenditure needs implies that there is no expectation that the health plan should spend precisely that amount on the individual. For example, although a national payment of (say) £550 per annum may be assigned to a person aged 45 to 64 in England, it would be absurd to expect every such individual to incur that expenditure in a particular year. Rather, the capitation payment offers an *expected* level of expenditure, around which there might exist substantial variation. Under these circumstances, the plan is expected to manage the risk inherent in the demand for the services for which it is responsible. Of course, nothing prevents a plan from cross-subsidizing one class of membership of its risk pool at the expense of another by changing the actual expenditure from the relative per capita levels implied by the capitation payments received for the two classes.

The capitation payments associated with the plan's members are summed to yield the plan's prospective budget. A number of risk management arrangements can be used for handling variations in actual expenditure from the prospective budget. These might entail:

- Renegotiating the budget retrospectively with the regulator or sponsor (as has effectively occurred in Italy and Spain);
- Running down (or contributing to) the plan's reserves (as in many systems of competitive insurance funds);
- Varying the future premiums, local taxes, or user charges paid by the plan members (as in Scandinavia and some competitive insurance markets); or
- In the extreme, explicitly delaying or rationing health care to the population at risk (as occurs to differing extents in the United Kingdom, Norway, and Sweden).

Clearly these arrangements imply big differences in the "hardness" of the budget constraint and other incentives confronting plans, a further important determinant of the effectiveness of the budgetary system.

In this paper, we survey the use of capitation methods in 20 developed nations. We discuss capitation methods in the context of four broad types of health care system found in these countries: competitive insurance markets, captive employment-based insurance, centralized public sector, and devolved public sector. The categories are somewhat flexible—for example, the notionally competitive Belgian system is, in many respects, far from competitive; the German competitive system retains many echoes of its precursor, which was employment-based; and the Spanish public system has elements of both devolution and centralization. However, they indicate the wide range of contexts within which a policy of capitation has been adopted and provide a useful framework for our analysis. We now discuss each of them briefly in turn.

A number of countries have implemented systems of *competitive insurance markets* in the last decade. The overriding policy objective has been to offer citizens a choice of insurance instruments, and thereby secure improvements in terms of efficiency, quality, and the choice of health care available. Most systems have been implemented in countries that have a tradition of social sickness insurance, which places a high priority on the notion of solidarity. The markets are therefore highly regulated. There is usually a mandatory package of care that must be offered. All systems insist that premiums be "community rated," in the sense that premium rates must be unrelated to health status, and that all applicants for insurance must be accepted regardless of their health status. In competitive insurance markets, insurers therefore have an incentive to skim off the "cream"—the relatively healthy members, with low numbers of dependents. The primary role of risk-adjusted capitation in competitive insurance markets is to reduce the incentive for "cream skimming."

Captive employment-based insurance is associated with unreformed systems of social insurance. Workers and their dependents are assigned to sickness insurance funds on the basis of the sector of the economy in which they work. Again, solidarity is often an important principle underlying such systems. If the sickness funds were to be completely freestanding (as is the case in Austria), then the premiums charged by each fund would depend on the health status of its members and its revenue base (usually the incomes of the employees insured). Thus, funds with a sicker, poorer membership will generally charge higher premiums than other funds. The key role of risk-adjusted capitation in captive systems is to reduce such inequalities in premiums. Examples in this survey are from France and Japan.

The archetype of the *centralized public sector* system is the National Health Service found in the four countries of the United Kingdom. Such systems are intended to overcome some of the market failures usually associated with health care, and are usually funded out of general taxation. They attach a high priority to notions of equity, especially in the sense that all citizens should enjoy equal access to health care according to health care needs, rather than on the basis of any other personal characteristics such as income, employment status, or area of residence. The management of such systems is usually organized on a geographical basis, and the main purpose of risk-adjusted capitation is to offer local areas the means to secure uniform national health care objectives. Other examples in this survey are from Italy, New Zealand, the state of New South Wales in Australia, and Alberta Province in Canada.

In *devolved public sector* systems, the management of health care is devolved from a national (or state) level of government to a lower tier of local government. Some or all health care is then funded by local taxes. If such devolution were complete, and a uniform package of care were specified, then local taxes would bear the entire burden of local need for health care, and would therefore depend on the health status of the local population and the size of the local tax base. In practice, this would result in great variations in local health care taxation. All such systems view the consequent variations in taxes as unacceptable, and so some intergovernmental transfers are effected, based on risk-adjusted capitation payments. The intention is to offer local areas the opportunity to levy a standard level of tax while delivering a standard package of health care. Examples covered in this survey are from Denmark, Finland, Norway, Spain, and Sweden.

Table 1 lists the systems surveyed in this study. Within all these systems of health care finance, two broad categories of argument have driven the move toward risk-adjusted capitation methods, relating to equity and efficiency. We now consider these in turn.

There are two dimensions of equity in health care: equal access to health care (for equal health needs) and equal payment for health care (whether through premiums or taxes) based on income or wealth. It is important to distinguish between these two equity issues. Equal access to health care (for equal need) implies that the resources of the health care plan should be distributed only in accordance with health care needs. Equal payments for equal income or wealth implies that financing should be according to ability to pay rather than level of sickness. In principle,

TABLE 1
Summary of the 20 Capitation Schemes Surveyed

Competitive insurance plans	Employer-based insurance plans	Public sector: devolved	Public sector: centralized
Belgium	France	Denmark	Australia
The Netherlands	Japan	Finland	(New South Wales)
Germany		Norway	Canada (Alberta)
Israel		Spain	Italy
Switzerland		Sweden	New Zealand
			United Kingdom
			(England, Scotland,
			Wales, Northern
			Ireland)

the two equity issues can be considered entirely separately. They become interlinked only if the sick are charged for the use they make of health care services.

In many nations, the equitable distribution of health care resources plays a central role in securing widespread support for health services funded out of general taxation, and explicit equity objectives underlying health care capitation are therefore most frequently found in centrally controlled public sector health care systems. Examples of such objectives are:

- "to monitor progress towards the achievement of fairness in health funding"—New South Wales Resource Distribution Formula (New South Wales Health Department 1999)
- "to overcome territorial inequalities in social and health conditions"—Italian regional resource allocation mechanism (Mapelli 1998)
- "to divide up funding equitably between the four . . . regions"—New Zealand Population Based Funding Formula (New Zealand Ministry of Health 1996)
- "to secure equal opportunity of access to those at equal risk"—English resource allocation formula (NHS Executive 1997)

These objectives reflect two concerns: to secure equity of health, and to secure equity of access to health care. The former objective is largely rhetorical, and few practical attempts have been made so far to adjust

capitation payments in order to address inequalities in health (an exception is a modest adjustment made for minority ethnic groups in the New Zealand Population Based Funding Formula). It is nevertheless worth noting that a new equity criterion is being contemplated in England of "contributing to the reduction of health inequalities." It remains to be seen whether this can be made operational. In practice, seeking to offer equal access to health care to those in equal need has hitherto been the equity objective—either explicit or implicit—underlying almost all schemes.

Equity objectives on the payment side have played an important role in prompting reforms to captive employment-based insurance systems. Without some transfer between funds, identical individuals will in general be charged different premiums, depending on the plan in which they find themselves. The rather crude adjustment schemes used in Japan and France, where a citizen's choice of insurance plan is limited, appear to reflect such equity objectives (Hoffmeyer and McCarthy 1994; Ikegami and Campbell 1999).

Furthermore, in systems of competitive insurance markets, there is usually a desire to create a "level playing field" for the insurers in the sense that, if risk adjustment were perfect, they would all have the opportunity to offer the same package of care at the same rate of premium, regardless of the risk profiles and incomes of their members. This effectively implies some concern with equity of payment. For example, the risk-adjustment scheme used in Germany for health care has the objective of reducing variations in insurance premiums between plans (Files and Murray 1995). However, the immediate reason for a concern with equality of payments in such systems is to help the insurance market function properly, rather than to treat citizens equitably.

A slightly different approach to equity underlies devolved public-sector systems of the sort found in Scandinavia, where local governments are responsible for organizing the majority of health care. Here, the central government supports health care expenditures with grants-in-aid, the main objective of such grants being to enable local communities to deliver a "standard" level of health care while levying a standard rate of local taxation (Rattso 1998). The equity objective relating to access, then, remains similar to that found in the centrally controlled state schemes. For example, the Finnish State Subsidy System seeks to secure "equality of opportunity of access for equal need" (Ministry of Social Affairs and Health 1996). However, local communities enjoy a certain

amount of freedom as to the level of health care they choose to offer, the associated local taxes they levy, and the user copayments they levy. Thus, such schemes implicitly seek equity based on equality of *opportunity* for local communities. A locality is able (in theory) to deliver a standard package at a standard rate of taxation—although, of course, the marginal increase in the local tax rate necessitated by a specified enhancement to the package may still vary considerably between localities, depending on their needs profiles and tax bases. Equalization is therefore secured only at the assumed national standard.

The principles of equity embodied in a devolved system of health care (either competitive insurance, captive insurance, or local government) can be summarized in a simple model as follows. Risk-adjusted capitation methods yield an estimate of health care expenditure needs of N_i for plan i. Suppose the revenue base of plan i is B_i. In a system of social insurance where premiums are income-related, B_i might be the taxable income of the members; in a local government system where the local source of revenue is property taxes, B_i might be the sum of taxable property values. Then, if each plan is self-financing, the rate of premium (or tax) r_i imposed by fund i would be given by $r_i B_i = N_i$, assuming that the needs assessment N_i is accurate. Premium rates would therefore depend on the ratio N_i / B_i.

If, on the other hand, plan i were to levy a national standard premium (or tax rate) r^*, it would generate a surplus of $B_i r^* - N_i$ (a negative result would yield a deficit). If r^* is then chosen so that $r^* \sum B_i = \sum N_i$, then the sum of the surpluses and deficits across all plans will be zero. By arranging an implicit contribution of $B_i r^* - N_i$ into a central pool (for plans with a surplus) or an implicit receipt from the central pool of $N_i - B_i r^*$ (for plans with a deficit), the desired equality of opportunity can be secured. All plans can, in principle, set an equal premium or tax rate if they deliver the standard package of care at a standard level of efficiency. This mechanism therefore simultaneously equalizes for variations between plans in health care needs and revenue bases. Of course, these calculations depend crucially on an accurate assessment of need N_i through the capitation methodology.

Because users of health care rarely bear the full marginal costs of their treatment, and also frequently have poor information on which to base treatment decisions, expenditure on health care has a tendency to exceed socially optimal levels. The problem of health care expenditure escalation has become a central policy concern in virtually all developed nations,

and numerous instruments for containing expenditure have been considered, the use of prospective budgets being one of the most important (Mossialos and Le Grand 1999). Where such budgets have been adopted, capitation approaches are generally considered the fairest approach to budget-setting, and such perception of fairness is often crucial to securing compliance with budgets by the plans (Milgrom and Roberts 1990). It is therefore important to keep in mind that the motive behind many capitation systems is to secure control of expenditures—a macroeconomic efficiency concern—and that there is an inextricable link between the equity and efficiency rationale for capitation.

Further efficiency considerations are conspicuous in the capitation schemes used for health care systems with competitive insurers (Van de Ven and Ellis 2000). The fundamental rationale for capitated competition is that, if all insurers are essentially able to deliver a standard package of care for a standard premium, then consumers can observe any residual variations in premiums or health care quality, and the pressure of the market will lead to improved efficiency. The adjustments brought about by capitation facilitate the operation of this market mechanism, which otherwise would be rendered opaque by the variations in risk profiles and revenue bases of the competing plans.

With no risk adjustment, competitive health plans always have an incentive to cream-skim the healthy, young, rich citizens with few dependents. Even if "open enrollment" is stipulated (under which a plan must, in principle, accept all applicants), Newhouse (1994) showed how plans can effectively deter high-risk applicants or encourage high-risk members to leave the plan. With risk-adjusted capitation, plans may still have an incentive to scrutinize potential members to assess whether their expected annual costs exceed their capitation payments and to reject those for whom this is the case. However, the potential gains are considerably reduced (Van Barneveld, Lamers, Van Vliet, et al. 2000). If left unattended, cream skimming would lead to increasing inequalities in premium rates and profit levels between plans that practice it and those that do not. In the extreme, it might lead to certain sections of the population being unable to find insurance, and a breakdown in the health care insurance market.

In this context, it is worth noting that most competitive insurance markets are highly regulated and, in practice, offer the plans little scope to secure efficiency improvements from providers, who continue to be reimbursed on the basis of activity (Brown and Amelung 1999). This

lack of leverage in pursuing provider efficiency increases the incentive for plans to target their energies either toward the socially wasteful activity of cream skimming or toward the inefficient practice of quality skimping (e.g., delivering less than the socially desirable level of care to high-needs patients). Risk adjustment seeks to reduce the manifest inefficiencies that emerge. More detailed discussions of the incentives that emerge in a competitive health care insurance market can be found elsewhere (Emery, Fawson, and Herzberg 1997; Giacomini, Luft, and Robinson 1995; Hutchison et al. 1999; McCarthy et al. 1995; Newhouse 1996; Oliver 1999; Van Barneveld, Van Vliet, and Van de Ven 1996; Van de Ven and Ellis 2000).

The policy prescription of capitation therefore emerges from both the equity argument and the efficiency argument sketched above. Essentially, a capitation system seeks to answer the question as to how—given that health care expenditure is to be constrained—the limited resources available should be distributed among health care plans in accordance with society's equity and efficiency objectives. The purpose of risk-adjusted capitation is to ensure that plans will receive the same level of funding for people in equal need of health care, regardless of extraneous circumstances such as area of residence and level of income.

How Are Capitation Payments Set?

Once the objective of allocating funds on the basis of capitation has been established, the question arises: How are the capitation payments to be derived? To answer this question, three fundamental choices must be made: the global amount of finance to be distributed for the service in question; the personal factors to be considered in any risk adjustment; and the weights to be placed on those factors. The first consideration—the global sum of money available—is mainly a political decision, and beyond the scope of this paper. We therefore concentrate on the choice of factors and the weights they are assigned.

We can think of the capitation payment for a given individual as that person's relative expenditure *needs*, and the characteristics to be taken into account in calculating those needs as *needs factors*. When choosing needs factors, the general principle should be that, *ceteris paribus*, they represent demonstrably material influences on the need to consume the health care service under consideration. This raises the important question as

to whose judgment should be used in deciding what constitutes "need" for a particular health care service. Such judgments could be primarily subjective. In practice, however, the main yardstick for deciding whether a putative "needs factor" should be used as a basis for risk adjustment has become whether it explains actual spending patterns among plans in a statistically significant manner. That is, the actual spending behavior of the health care sector is used to infer appropriate needs factors.

Of course, in seeking to model existing determinants of health care utilization, it may not be possible to accommodate some aspects of so-called unmet need within the capitation methodology. Unmet need can be either general or specific. General unmet need arises when the services provided are considered inadequate to meet expected standards for the population at large, perhaps because of inadequate aggregate funding. In these circumstances, the organization under scrutiny usually will nevertheless allocate spending to citizens in proportion to need, so that its spending pattern offers useful information on the *relative* needs of recipients of services. It is therefore assumed that there is no systematic discrimination against classes of individuals.

Specific unmet need, on the other hand, arises when particular groups within the population—such as ethnic minorities, residents of rural areas, or patients with particular conditions—are not receiving the services to which they are entitled, when compared with the general pattern of utilization within the population as a whole. Under these circumstances, the use of empirical spending patterns to infer needs is problematic, as the models developed will perpetuate the implied inequity.

At the opposite end of the spectrum to unmet need is the possibility of unjustified utilization, which can take the form of supplier-induced demand or excessive use of services by some groups of the population. (We do not propose here to pursue what might be considered "excessive" in this context, other than to state that it reflects utilization in excess of what is usually considered to be the standard package of care.) The possibility of both unmet need and unjustified utilization has been the subject of great concern among researchers seeking to infer capitation payments from empirical data—particularly in England, where the econometric methods in use are designed specifically to minimize the impact of supply factors on estimates of capitation payments (Carr-Hill, Sheldon, Smith, et al. 1994).

In the extreme, if enough explanatory factors were included in the model, using an empirical model of actual health care spending patterns

to set capitation payments would result in simply replicating those spending patterns, which would defeat the purpose of capitation. The intention is usually to model the level of expenditure that would arise given some standard set of circumstances. From a statistical viewpoint, this suggests that developing statistical models that seek to maximize the explanation of existing spending patterns is not necessarily a desirable objective in itself. Rather, the intention should be to explain variation caused by *legitimate* (needs) factors, and to ignore variation caused by irrelevant factors, such as variations in the efficiency levels, accounting methods, or policy choices of individual plans. To distinguish these irrelevant factors from legitimate needs factors, we call them *illegitimate* (non-needs) factors, although the literature often refers to them as *supply factors*. In using this expression, we are not implying that the policy influences of individual plans on expenditure are necessarily illegal or undesirable. We are merely indicating that, for the purpose of deriving a general set of capitation payments, their influence on expenditure patterns should be ignored, if at all possible. Associated with the issue of legitimate versus illegitimate factors is the need for risk-adjustment mechanisms to address the inescapable (as opposed to supplier-led) variations in input costs between health plans.

Whether a factor is considered legitimate may be a matter of the policy context within which the capitation scheme is embedded. This consideration is particularly important in relation to provider costs. In England, the tradition has been to assume that health plans are unable to control variations in general input prices caused by local economic factors, so some adjustment is made for such variations using general wage data and land prices. However, every effort is made to avoid basing adjustments to capitation payments on health sector prices, as these might be influenced by local health plan policy. In contrast, the Netherlands risk-adjustment scheme uses five categories of "urbanization," for which the capitation payment can vary (say) from minus 11 percent (rural) to plus 18 percent (heavily urban) in specialist health care (Ziekenfondsraad 1999). No attempt is made to determine whether some of the variations in costs might be due to variations in supply. The assumption appears to be that health plans are unable to control such variations in costs, and so must be appropriately reimbursed. Such issues have been the subject of strong debate within competitive health care markets—such as Belgium, Germany, and the Netherlands—where the extent to which plans can control the supply of local physicians and provider prices is in

dispute (Schokkaert and Van de Voorde 2000; Van de Ven, Van Vliet, Van Barneveld, et al. 1994).

Furthermore, it is desirable to avoid using needs factors that are vulnerable to manipulation by the recipient agencies, or that create perverse incentives. For example, many studies have found that a history of previous inpatient utilization is a good predictor of current utilization (Van Vliet and Van de Ven 1993). However, previous utilization may often be ruled out as a suitable capitation factor because it is considered vulnerable to manipulation by providers, and may create an incentive for providers to offer more care than is strictly necessary, to distort reports of diagnoses, or to indulge in other deceptive activity, in order that the plans purchasing care can attract higher capitation payments in the future. Indeed, in the extreme case where past expenditure is used as a crude predictor of future expenditure, the system of financing might effectively revert to one of full retrospective reimbursement.

The selection of needs factors to consider in a health care capitation has been a highly complex and controversial process. At least six reasons can be put forward for this:

- Relevant data are often in short supply.
- Research evidence on appropriate needs factors is sparse, dated, or ambiguous in its implications.
- There is great difficulty in establishing the extent to which a particular needs factor is independent of other needs factors, that is, in handling covariances between needs factors.
- It is difficult to disentangle legitimate needs factors from other policy and supply influences on utilization.
- It is often difficult to identify the health care costs associated with a proven needs factor.
- The recipients of devolved budgets often feel they have a clear idea about which needs factors will favor their plan, and so will seek to influence the choice of needs factors through the political process.

Once needs factors have been identified—in whatever fashion—they must be weighted to reflect their relative influence on the need to spend. The usual approach to both variable selection and estimation is to use regression-based statistical methods of varying levels of refinement. At its simplest, the estimation process may entail identifying the average expected health care expenditure for a citizen with certain characteristics

(age, sex, ethnicity, etc.). Such methods require the necessary individual-level data to be available. In many systems, however, only aggregate data are available, requiring analysis of utilization at the plan level or some convenient level of disaggregation (e.g., small areas). We have found that such analyses have been performed with varying levels of refinement and statistical rigor.

Thus, risk-adjustment processes employ two broad approaches to setting capitation payments, based on individual-level data and aggregate data. Generally, under the individual approach, one or more dimensions of need (e.g., age, sex, ethnic status, disability status) are used to create a matrix of payments, in which each entry represents the expected annual health care costs of a citizen having the associated characteristics. Therefore, the matrix might comprise (say) eight age categories, two sex categories, three ethnic status categories, and two disability status categories, giving rise in its unadulterated form to 96 cells ($8 \times 2 \times 3 \times 2$), each of which would require a capitation payment estimate.

Several schemes use an individual approach based on age alone (France, Israel, and Japan) or on age and sex (Germany and Switzerland) (Babazono, Weiner, Tsuda, et al. 1998; Beck 1998; Chinitz 1994; Files and Murray 1995; Haut Comité de la Santé Publique 1999). At the other extreme, the individual approach is exemplified by the matrix of capitation payments developed in Stockholm County and proposed for use at a national level in Sweden (Andersson, Varde, and Diderichsen 2000; Diderichsen, Varde, and Whitehead 1997). This extends the familiar age/sex risk adjustment to include variables such as marital status, housing tenure, and employment status, as well as previous health care utilization. It is made possible by the comprehensive personal record of social circumstances and health care utilization maintained for all Swedish citizens. For empirical estimation purposes, the individual approach usually requires a substantial database of individual-level data for which all the relevant needs factors are recorded; and for allocation purposes, it requires universal and reliable recording of individual-level data among health care plans. Other individual-level schemes are found in Alberta (Alberta Health 1998), the Netherlands (Ziekenfondsraad 1999), and New Zealand (New Zealand Ministry of Health 1996).

Statistical or judgmental methods can be used to reduce the number of cells employed within the matrix of individual circumstances. For example, in the Netherlands, age (19 categories), sex (two categories), urbanization (five categories), and employment/disability status (five

categories) are used as the basis for risk adjustment, implying the need to estimate 950 capitation payments ($19 \times 2 \times 5 \times 5$). In practice, the problem is reduced by setting a rudimentary matrix of capitation payments for age and sex ($19 \times 2 = 38$ cells). It is then assumed that the impact of urbanization and employment/disability status is independent of age and sex. The dimension of the problem can then be reduced considerably by assuming (say) that the same urbanization factor applies to all citizens in rural areas, regardless of age and sex. This means that just five urbanization and five employment/disability factors need to be defined, in addition to the 38 age/sex payments (Ziekenfondsraad 1999). An alternative approach to reducing the dimension of the matrix is to combine adjacent cells that are either very sparse or that show little variation in expenditure, which is the method employed in Stockholm County (Andersson, Varde, and Diderichsen 2000).

Because of the limitations associated with individual-level data, many risk-adjustment schemes resort to using more aggregate data relating to the plan as a whole. Under the index approach, aggregate measures of the characteristics of a plan's population (or part of the population) are combined to create an index, which seeks to indicate the aggregate spending needs of the associated population. An example is the Belgian risk-adjustment scheme, which employs a series of such indices based on factors such as demography, mortality, population density, proportion unemployed, proportion disabled, and housing quality (Schokkaert and Van de Voorde 2000). The use of the index approach opens up the potential for an enormous increase in the data that can be used as the basis for capitation payments. In particular, where plans are based on geographical entities, national census data often become available as the basis for setting expenditure targets.

However, a new problem emerges when capitation payments are based on such aggregate data: the *ecological fallacy* (Selvin 1958). This is the possibility of identifying a relationship between a putative needs factor and health care expenditure at the aggregate level that does not hold at the individual level—which is the focus of capitation methods. One possible source of the ecological fallacy is illustrated in figure 1. In this example, there are three health care plans (HP1, HP2, HP3). The numbers in the diagram refer to individuals within each plan. Health care needs are measured using individual data. The expenditure responses of each plan to variations in need are roughly similar, as shown by the slopes of the regression lines for each plan. However, plan HP1 devotes a higher level

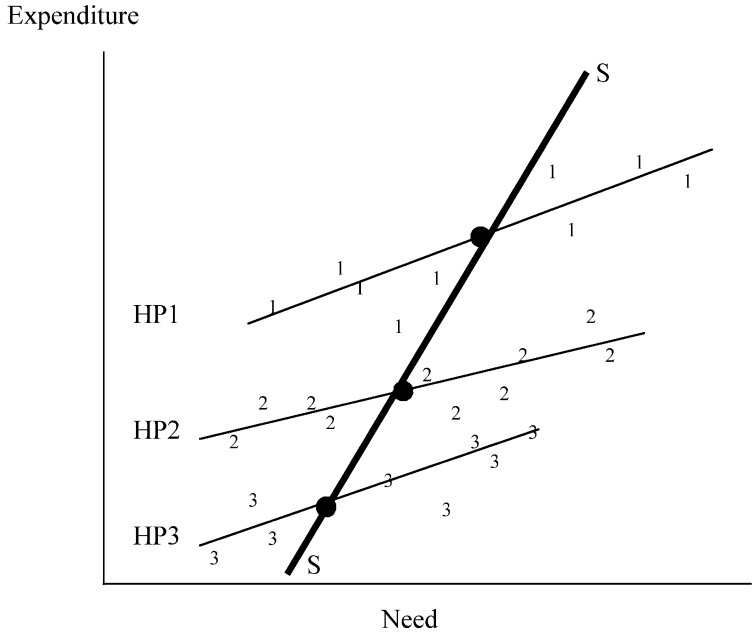

FIG. 1. The "ecological fallacy" illustrated.

of resources to health care than HP2, which in turn devotes more than HP3. The *average* needs and costs of each plan are indicated by the black circles. If these averages are used in a regression, the thick regression line SS may result. This line bears no relation to actual responses to needs within local authorities, and may be mainly determined by variations in expenditure policy between health plans.

This phenomenon reflects the fact that aggregate-level expenditure data may reflect both individual needs (legitimate factors) and supply considerations (illegitimate factors), and that to disentangle the two using aggregate data poses profound methodological difficulties. Most analysts seem to have been aware of the potential for this problem, and many have sought to minimize it by using disaggregate data wherever possible, but are often constrained by data limitations. The English approach to identifying needs factors uses small geographic areas (rather than individuals) as a basis for estimating needs factors. This is justified on the grounds that it permits access to a rich aggregate data source (the national census), but avoids use of larger administrative units of analysis, thereby reducing the attendant danger of the ecological fallacy (Royston,

Hurst, Lister, et al. 1992). The fulcrum of the method is multilevel (or hierarchical) statistical modeling, offering the most technically advanced approach to estimating needs factors reported to date (Rice and Jones 1997). This approach seeks to identify expenditure responses to potential needs factors after extracting any plan-level effect. It has been tested in numerous geographically organized systems of health care, in Finland, Northern Ireland, Quebec, Scotland, and Spain, for example (Carr-Hill et al. 1994; Department of Health and Social Services 1997; Häkkinen, Mikkola, Nordberg, et al. 1996; Pampalon 1998; Rico 1997; Scottish Executive Health Department 1999).

Several capitation schemes use a hybrid approach. Preliminary expenditure estimates are based on rudimentary individual-level data (such as age and sex). The entire matrix of capitation payments is then adjusted by an aggregate index specific to each plan. This is the method used in the countries of the United Kingdom, where initial payments are set on the basis of age (and sometimes sex), with a further adjustment based on an index of local population characteristics (Department of Health and Social Services 1997; NHS Executive 1997; Scottish Executive Health Department 1999; Welsh Office 1998). The method is also applied in one form or another in Finland (Ministry of Social Affairs and Health 1996), Italy (Mapelli 1998), and New South Wales (New South Wales Health Department 1999).

The considerations noted above imply that complex statistical and econometric considerations often surround the development of capitation payments based on empirical data. In principle, the methods used should be able to accommodate serious data limitations, to distinguish between legitimate and illegitimate sources of variation in utilization, and to offer results that are statistically robust and readily implemented as a capitation formula. Use of aggregate data can introduce the additional problem of the ecological fallacy. Although widely recognized, there have been few serious attempts to address these methodological issues, and most current methods use fairly rudimentary statistical methods.

Findings

In this section, we review our findings for the 20 individual schemes under scrutiny. Table 2 summarizes for each locale the capitation scheme used, the plans to which finance is devolved, the needs factors used at an

TABLE 2
Summary of Capitation Systems in 20 Countries

Country	Scheme	Plans	Individual level	Aggregate level	Other factors
Australia	New South Wales Resource Distribution Formula	17 Area Health Services (geography)	Age Sex Ethnic group Homelessness	Mortality Education level Rurality	Private utilization Cross-boundary flows Cost variations
Belgium	National Institute for Sickness and Disability Insurance risk adjustment scheme	100 sickness funds (competitive)		Age Sex Unemployment Disability Mortality Urbanization	
Canada	Alberta Population Based Funding model	17 Regional Health Authorities (geography)	Age Sex Ethnicity Welfare status	Remoteness	Cross-boundary flows Funding loss protection Cost variations
Denmark	Local Government Finance System	14 County Councils (geography)	Age	Age Children of single parents	Local tax base
England	Resource Allocation Formulae	100 health authorities (geography)	Age	Mortality Morbidity Unemployment Elderly living alone Ethnicity Socioeconomic status	Cost variations

continued

TABLE 2—*continued*

Country	Scheme	Plans	Individual level	Aggregate level	Other factors
Finland	State Subsidy System	452 municipalities (geography)	Age Disability	Archipelago Remoteness	Tax base
France	Regional resource allocation	25 regions (geography)	Age		Phased implementation
Germany	Federal Insurance Office risk adjustment scheme	Sickness funds (employment/ competitive)	Age Sex		Income base
Israel	National risk adjustment scheme	4 sickness funds (competitive)	Age		Removal of five serious diagnosis categories
Italy	Regional resource allocation system	21 regional governments (geography)	Age Sex	Mortality	Damping mechanism
Japan	Elderly Health Care System	Numerous insurance plans	Age		
Netherlands	Central Sickness Fund Board risk adjustment scheme	26 sickness funds (competitive)	Age Sex Welfare/ disability status	Urbanization	Retrospective adjustments Income base
New Zealand	Health Funding Authority Population Based Funding Formulae	4 regions (geography)	Age Sex Welfare status Ethnicity	Rurality	Phased implementation

Northern Ireland	Health Board Allocation Formula	4 health boards (geography)	Age Sex	Mortality Elderly living alone Welfare status Low birth weight	Rural costs adjustment
Norway	Local Government Finance System	19 county governments (geography)	Age Sex	Mortality Elderly living alone Marital status	Tax base
Scotland	Health Authority Revenue Allocation scheme	15 health boards (geography)	Age Sex	Mortality	Rural costs
Spain	Regional resource allocation system	7 Comunidades Autónomas (regions) (geography)			Cross-boundary flows Declining population adjustment
Sweden	Stockholm County hospital resource allocation formula	9 Health Care Authorities (geography)	Age Living alone Employment status Housing tenure Previous inpatient diagnosis		Phased implementation
Switzerland	Federal Association of Sickness Funds risk adjustment scheme	Sickness funds (competitive)	Age Sex Region		Income base
Wales	Health Authority allocation formula	5 health authorities (geography)	Age Sex	Mortality	Sparsity cost adjustment

individual level, the needs factors defined at an aggregate level, and any other notable features of the scheme.

Almost all the risk-adjustment mechanisms are based largely on empirical data and rely predominantly on analyses of existing patterns of health care utilization. The exceptions are Spain, where there is no risk adjustment (Consejo de Politica Fiscal y Financiera 1998); Norway, where empirical results are moderated by political judgment (Van den Noord, Hagen, and Iversen 1998); and Italy and Scotland, which use standardized mortality ratios as a needs adjuster, without direct reference to the link between the ratios and utilization (Mapelli 1998; Scottish Executive Health Department 1999). Few systems adjust for unmet need, an exception being the New Zealand formula for personal health care, in which an explicit adjustment is made to take account of the fact that the Maori population is believed to underuse health care facilities (New Zealand Ministry of Health 1996).

"Supplier-induced demand" has been the subject of some concern in England, and has played a central role in determining the selection of needs factors there (Carr-Hill et al. 1994). Although other countries have raised similar concerns, they have done little to address the issue—except Belgium, where there has been considerable debate over whether to retain physician supply in the regression equations used to distribute funds to health plans (Schokkaert, Dhaene, and Van de Voorde 1998). The outcome has been that supplier-induced demand has been excluded from the calculations, meaning that health plans are not compensated for variations in the physician supply available to their beneficiaries, even though the plans may have no control over the consequent variation in utilization.

Almost all schemes adjust for variations in unit costs between geographical areas. For example, to avoid some elements of local price variation, many schemes use standard diagnosis related group (DRG) costs when measuring utilization to estimate capitation payments (Alberta Health 1998). However, major variations often remain in per capita expenditure between geographical areas, even after adjusting for uncontrollable variations in input prices and health care needs. A typical approach, as used in the Netherlands, is to include variations in local expenditure in the capitation formulas, even though an element of supply may cause some of the variation (Ziekenfondsraad 1999).

Many public sector schemes—such as those in England, Northern Ireland, Finland, New South Wales, New Zealand, and Scotland—adjust

for the putative higher costs of delivering some services in rural areas using a variety of methodologies. The English system makes quite marked adjustments for differences in input prices between the London area and the rest of the country (NHS Executive 1997).

Table 2 gives an indication of the needs factors used at an individual level and at the plan (aggregate) level, confirming the widespread use of hybrid methods. In general, the schemes used within competitive markets use simpler methods and have been less adventurous than the public sector schemes, often basing risk adjustment on age and sex alone. This may reflect the lack of data on which capitation payments can be based, or may be the result of the more complex political and legal environment within which the scheme must operate. Many of the geographically based schemes have been far more adventurous: they have sought to link spending needs to a wide range of social and demographic variables, using different methods.

As table 2 indicates, numerous types of risk-adjustment variables have been incorporated into the schemes. The choice of many—if not most—appears to have been influenced more by availability of data than by compelling evidence of a link with health care expenditure needs. It is important to note that, although a factor might be included in a capitation formula, it may not necessarily have a strong influence on the allocation of funds. The types of factors can be considered under seven broad headings: demography, ethnicity, employment/disability status, geographical location, mortality, morbidity, and other social factors. We discuss these briefly in turn.

Demography: Only one of the capitation schemes (Spain's) fails to take some account of demographic factors in the form of age and (usually) sex groups. The crude per capita allocation used in Spain seems to result from the political impossibility of implementing a mechanism based on a regional consensus that is more sensitive to spending needs, rather than on scientific evidence (Consejo de Politica Fiscal y Financiera 1998).

Ethnicity: Several schemes make an explicit adjustment for a citizen's ethnic group—treating ethnicity in the same way as age and sex, and effectively making it a third dimension of demography. Examples are the three-way classification use in New South Wales (aboriginal, Torres Strait Islander, other), a similar scheme in New Zealand (Maori, Pacific Islander, other), and an aboriginal category in Alberta (Alberta Health 1998; New South Wales Health Department 1999; New Zealand Ministry of Health 1996).

Employment/disability status: Several areas we studied—the Netherlands, New Zealand, Alberta, Northern Ireland—use a statutory measure of employment and/or disability status (e.g., social security categories) as a basis for risk adjustment. For example, the Dutch scheme uses five categories: employed, permanently sick, temporarily unable to work, unemployed, pensioner (Ziekenfondsraad 1999). These indicators have the advantage that they are universally recorded and are regularly updated. Their main disadvantages are that they are not specifically designed for capturing variations in health care needs and that they are vulnerable to systematic misrecording or manipulation. Furthermore, they are at their weakest within the population for which risk adjustment is most important—those of pensionable age.

Geographical location: Geography may have an important influence on expenditure for three reasons: variations in need (not captured by other factors), variations in the extent to which need is expressed (in the form of utilization), and variations in local health care supply and policy. As discussed above, disentangling these sources of variation on health care costs is a profound problem that has rarely been seriously addressed. The primary focus has been on variations in input prices and costs, rather than on variations in health care needs associated with geography.

Mortality: Mortality rates (crude and standardized) are used in New South Wales, Belgium, Wales, Scotland, Northern Ireland, Italy, New Zealand, and Norway. They usually have the advantage of being universally recorded and verifiable. However, the nature of the link between mortality rates and the need for health care is a matter for debate.

Morbidity: In many respects, morbidity is the individual characteristic most closely related to health care needs, and can be an important risk-adjustment variable in systems that seek to avoid cream skimming. On the other hand, there is a fear that the use of morbidity data as a risk-adjustment variable may lead to gaming on the part of providers. Many health care systems also lack reliable and verifiable morbidity data. In practice, even competitive health insurance systems have made little use of measures of previous health care utilization or diagnosis, which are much used in U.S. capitation methods (Ash, Porell, Gruenberg, et al. 1989; Clark, Von Korff, Saunders, et al. 1995; Ellis, Pope, Iezzoni, et al. 1996; Fowles, Weiner, Knutson, et al. 1996; Weiner 1996). Morbidity is sometimes incorporated using statutory measures of permanent disability, such as those used in Belgium, Finland, and the Netherlands. The Northern Ireland formula for acute care includes a measure of low birth

weight in infants, one of the rare morbidity measures that is universally and consistently recorded. Israel's is the only scheme that specifically excludes patients with certain diagnoses from the risk-adjustment scheme (Shmueli, Shamai, Levi, et al. 1998), although a similar approach is under consideration in Sweden (Andersson, Varde, and Diderichsen 2000).

Social factors: Numerous social factors can be found in risk-adjustment schemes, their use being predominantly opportunistic (that is, usually based on data availability rather than on a direct link to health care needs). Examples include:

- Homelessness (New South Wales)
- Educational attainment (New South Wales)
- Unemployment (Belgium, the Netherlands, Stockholm)
- Welfare status (Alberta, New Zealand, Northern Ireland)
- Marital status (Norway, Stockholm)
- Family structure (Norway)
- Housing quality (Belgium)
- Housing tenure (Stockholm)
- Social class (Stockholm)
- Cohabitation (Stockholm, Northern Ireland)
- Income (Finland)

Although many of these data are recorded in national censuses, and are therefore universally and (reasonably) consistently recorded, they quickly become dated and represent, at best, an indirect link to the need for health care. Empirically, in the absence of more direct measures of health care needs, some social factors (e.g., family structure and welfare status) have been found to be strongly linked to health care utilization. However, there is some concern that such relationships might reflect illegitimate supply factors rather than underlying health care needs (Carr-Hill et al. 1994).

Ideally, any factors on which risk adjustment is based should incorporate only characteristics that are universally recorded (across all plans in receipt of funds), consistent, verifiable, free from perverse incentives (e.g., cream skimming or gaming), not vulnerable to manipulation, consistent with confidentiality requirements, and plausibly determinative of service needs. Our survey has found that, in practice, these criteria have severely limited the choice of variables, as in most systems few data exist that conform to them. Table 3 describes, in brief and subjective form, the extent to which the broad categories of factors considered in

TABLE 3
Assessment of Usefulness of Types of Risk Adjustment Variables for Capitation Purposes

	Demography	Ethnicity	Employment/ Disability	Geographical location	Mortality	Morbidity	Social factors
Universally recorded	++	+	?+	++	++	−−	?+
Consistent	++	+	++	+	+	−−	?+
Verifiable	++	+	+	+	+	−	?+
No incentives for cream skimming	++	+	+	++	+	++	+
No incentives for gaming	++	+	?	++	+	−−	−
Not vulnerable to manipulation	++	+	+	++	++	−−	−
Confidentiality respected	++	+	−	+	+	−−	?
Plausible	−	−	− employment + disability	−−	?−	++	−

this section are consistent with the criteria. The plus symbol (+) indicates our judgment of good performance with respect to the criterion; the minus symbol (−) reflects poor performance. Note that, although performing well on most criteria, demographic data have only limited plausibility in explaining health care utilization, while morbidity data perform poorly on most criteria other than plausibility and reducing incentives for cream skimming.

Finally, it is important to note that capitation schemes have often been phased in most cautiously. There has been a general reluctance to change rapidly from historical levels of expenditure, or to implement immediately the revised financial allocations associated with new capitation methods. Most financial allocations derived using the methods described above are therefore phased in gradually to avoid large fluctuations in budgets. For example, some schemes (as in Alberta) guarantee that no allocation will be cut in real terms, and merely direct growth money to plans currently below their expenditure targets. The Norwegian scheme is deliberately weighted according to previous actual activity, and the prospective capitated allocations play only a subsidiary role in determining allocations. Some schemes (most notably in the Netherlands) have in place an elaborate retrospective "safety net" to offer some protection to plans from variations in actual expenditure away from budgets.

Conclusions

Capitation is, without doubt, here to stay. There is a remarkable degree of agreement that—whatever the structure of the health care system—a policy of cost containment and devolved responsibility for health care requires setting prospective budgets on the basis of capitation payments. The question is therefore not *whether* to set capitations, but *how* to do so.

To some extent, the preoccupations of capitation schemes are determined by the health care systems they seek to serve. For example, the main objective of competitive insurance market systems is to minimize cream skimming, and requires focus on the individual. The treatment of area-level effects on estimates of capitation payments is highly problematic within such schemes, as inadequate handling of this issue may induce insurers to withdraw from offering coverage to entire areas—the crudest form of cream skimming. Approaches to this issue are still in their infancy. In due course, the preoccupation with cream skimming

and lack of alternative data may make the use of prior utilization data attractive as a basis for risk adjustment in such settings.

Systems with captive insurance markets tend to be concerned more with demonstrating equitable treatment and avoiding perverse incentives at a population level. Thus, the use of prior utilization data was hitherto considered inappropriate, as it might adversely affect provider behavior. There is less need to be constrained to using individual-level data, however. The use of aggregate-level data opens up a richer source of information but has led to the use of quite elaborate statistical methodologies, which may require careful audit.

To a large extent, the systems in use have been chosen on the basis of expediency, most notably in terms of the data available to policymakers. Thus, many schemes have been constrained to the use of crude age and sex adjustments, in the full knowledge that such data are woefully inadequate, because they are all that are available and are better than nothing. Given the very large sums of money redirected by risk-adjustment schemes, we have been surprised at the lack of investment in new data sources, and think that—if the equity and efficiency objectives underlying capitation are genuinely considered important—there is a strong case for making such investment.

If suitable individual-level data were available, we have little doubt that the individual-level approach, epitomized in the Stockholm model, is the most methodologically satisfactory method of setting capitation payments because it minimizes the ecological problem associated with the use of more aggregate data—although there is still need for caution in accommodating potential supply effects (Carr-Hill, Rice, and Smith 2000). Imminent developments in information technology may lead to rapid increases in the availability of individual-level data, and policymakers should, in our view, be ready to take the opportunity they offer and—if possible—to influence the form they take.

The principal task confronting designers of data systems based on individual-level information is to develop objective indications of health status that can be used as sensitive indicators of expenditure needs. To date, most of the systems for inferring chronic diagnosis have been based on prior utilization, and the extent to which these methods introduce perverse incentives has rarely been satisfactorily addressed.

Fundamental to an examination of the suitability of a particular scheme is the issue of who carries the responsibility and who bears the risk for variations in expenditure from assumed capitation payments. Although many of the schemes examined appear rudimentary, they are

serving financing systems in which the health care plan does not necessarily bear a great deal of risk. This is often because in practice, the central authority bears a large part of the financial risk in one form or another—either by partially reimbursing amounts that are overspent or by renegotiating budgets. Alternatively, the health plan may be able to meet overspent amounts by varying the premiums or the local tax rates. The capitation system cannot be considered in isolation from the risk-sharing arrangements in place, and there is scope for more research on how the two interact.

Geographical variations in the costs of providing a standard level of service have been a concern of a number of the schemes we surveyed. The methodologies adopted have, on the whole, been rather rough-and-ready, and have addressed major sources of cost variation, such as extreme remoteness. There appear to have been few satisfactory attempts to address the issue of unmet need, or to distinguish between legitimate and illegitimate sources of cost variations. This area of research also may benefit from some fundamental conceptual study.

In summary, the optimal solution to making capitation schemes operational depends on reconciling a number of objectives, including:

- To further society's objectives for health care;
- To seek to make capitation payments as sensitive as possible to legitimate health needs factors;
- To seek to make capitation payments as independent as possible from illegitimate factors;
- To maximize the availability of high-quality data on which the capitation payments can be based;
- To minimize the dysfunctional incentives introduced by capitation;
- To integrate systems of risk management with the capitation scheme;
- To design health care systems that are impervious to the limitations of capitation schemes; and
- To minimize the costs of administering the capitation scheme.

In principle, the effectiveness of any capitation system should be evaluated with respect to objectives such as these. However, it is rare to find an explicit statement of objectives for a capitation scheme along these lines, let alone an attempt to evaluate its success (or otherwise).

Achieving these objectives is a demanding task—indeed, it is difficult to envisage any system that could satisfactorily reconcile them all. The schemes we reviewed here offer a wide spectrum of experience and lessons.

It is clear that none of them can serve as the model for all the others, and that the most appropriate approach is likely to be heavily dependent on the institutional framework within which capitation must operate. We nevertheless believe that the accumulated experience reported here is likely to offer almost all designers of capitation schemes considerable food for thought.

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